# ICL CALIBRATION LABORATORIES, INC.

*ISO/IEC 17025 and ANSI/NCSL Z540-1 accredited*
*The specialists in ASTM and laboratory thermometers & hydrometers*
Members: **A2LA ASTM API NCSLI ASQ NCWM**
*Setting new standards in calibration excellence!*

Cert 526.01 Calibration

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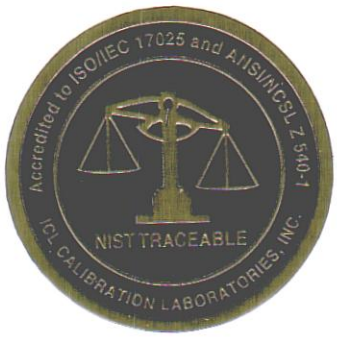
## CALIBRATION REPORT FOR LIQUID-IN-GLASS THERMOMETER

*The instrument or device identified below was examined and calibrated in ICL's metrology laboratory following the calibration procedure referenced below. This calibration fulfills the requirements of ISO/IEC 17025-2005, 'General Requirements for the Competence of Testing and Calibration Laboratories' and ANSI/NCSL Z540-1-1994, 'Calibration Laboratories and Measuring and Test Equipment - 'General Requirements'.*

### CLIENT
*US EPA R5 CRL*
*536 S. CLARK, 10TH FLOOR*
*CHICAGO, IL 60605*
*Purchase order number: NOT AVAILABLE*
*Submitted by: US EPA R5 CRL*
*ICL internal reference (SO): 367829*




### DATES
*Date received: 08-21-2017*
*Date report issued: 09-15-2017*
*Next due (specified by client): September 15, 2018*

### UUT (Unit Under Test) INFORMATION
*ID or asset number assigned by client: ID SETAFLASH3*
*Manufacturer, brand or marking: ERDCO Serial No: 85C020*
*Engineering units: degrees Fahrenheit (°F)*
*Range: 32 to 230 °F Scale divisions: 1.0 °F Immersion: 44.5MM*
*Accuracy tolerance (maximum permitted scale error): +/- 2.0 °F (NIST SP 250-23)*

### RESULTS OF PHYSICAL EXAMINATION
*This instrument was examined under a polarized lens and strains in the glass, if any, were judged to be minimal and of no detriment to the function of the instrument. The capillary of this thermometer was examined under 20X magnification. No foreign material, moisture, or other evidence of contamination were discovered, unless noted below. No discernible capillary irregularities were noted. It was determined that this instrument is in good working order and is therefore suitable for calibration.*

### CALIBRATION PROCEDURE
*ICL Procedure 01, which is based on ASTM E77 and NIST Special Publication 250-23.*

### LABORATORY ENVIRONMENTAL CONDITIONS
*Temperature: 23 °C +/- 5 °C, Relative humidity: between 30% and 80%*

### RESULTS OF CALIBRATION
*NOTE: The indications of this instrument cannot be adjusted or modified by ordinary means; accordingly, the readings given in the table below should be considered, in effect, to be both 'As Found' and 'As Left' readings.*

| Nominal | Standard Rdg | UUT Reading | Correction | Tolerance | Accept Limit* | P/F/Ind | Stem temp | Uncertainty |
|---|---|---|---|---|---|---|---|---|
| 81.00 °F | 81.004 °F | 81.9 °F | -0.9 °F | ± 2.0 °F | ± 2.00 °F | Pass | 76 °F | ± 0.23 °F |
| 140.00 °F | 139.997 °F | 140.2 °F | -0.2 °F | ± 2.0 °F | ± 2.00 °F | Pass | 75 °F | ± 0.24 °F |

*Unless otherwise stated, the thermometer was permitted to stabilize for a minimum of 5 minutes at each test temperature prior to reading.*

### GUARD BANDING
*ISO/IEC 17025:2005(E) requires, in Section 5.10.4.2., that, "When statements of compliance are made, the uncertainty of measurement shall be taken into account." One valid way of complying with this requirement is applying a 'guard band' to the device's tolerance. The guard band is calculated as a function of the test uncertainty ratio (TUR), the ratio of the tolerance of the UUT to the measurement uncertainty. Basically, the smaller the uncertainty is relative to the tolerance, the smaller the guard band. A TUR of 5:1 typically results in a guard band of zero, or nearly zero. A 4:1 TUR produces in a guard band very close to zero. A 3:1 TUR results in a modest guard band. And so forth. As TUR declines, the guard band becomes larger. The use of the guard band in the decision process is designed to reduce the probability of a false acceptance (PFA), or a false failure, to 2% or less. The method and equations we use for calculation of the guard band comply with the requirements of ANSI/NCSL Z540.3*

*The *Accept Limit(s) are calculated by subtracting the guard band from the tolerance. The Accept Limit is essentially a new tolerance, for this calibration only, which we use to make a declaration of Pass, Fail, or Indeterminate, as explained below:*

*Pass The measured value falls within the interval described by the test point plus or minus the Accept Limit.*
*Fail The measured value falls outside the interval described by the test point plus or minus (the tolerance + the guard band).*
*Ind (Indeterminate) The measured value is indeterminate, falling in that statistical 'grey' area, too close to permit a credible determination. It is statistically and metrologically imprudent to declare that the instrument is definitively either 'in-tolerance' or 'out-of-tolerance'.*

### LIMITATIONS OF USE

*The calibration performed is a limited, or partial-range calibration, and accordingly, limitations of use are imposed as follows:*

*This thermometer can be used with confidence only at (and within a few scale divisions of) the test point(s) calibrated and between any two test points, provided there are no more than 100 scale divisions between those test points.*

### MEASUREMENT UNCERTAINTY

*The measurement uncertainty reported is the expanded uncertainty at 2 sigma (k=2), to provide a confidence level of approximately 95%.*

*The uncertainty is calculated considering both Type A and Type B contributors. Type A contributors include the standard deviation of the measurement process from check standard control charts, comparator uniformity, the standard deviation of monthly Triple Point of Water calibrations of the standard, and UUT variability observed during the calibration. Type B contributors include the uncertainty of the calibration of the reference standard, stem conduction and other immersion effects, the sensitivity and accuracy of the reference standard thermometer's readout, resolution of the reference standard and resolution of the UUT. For this partial immersion liquid-in-glass thermometer, additional Type A contributors were calculated to account for the ambiguity of accurately measuring the temperature of the emergent liquid column (see ASTM E77), and the effect of those potential errors on the volume of the emergent liquid column, and in turn, on the indications of the thermometer.*

*The Type A and B contributors are combined using the root-sum-square method to obtain the standard uncertainty at 1 sigma. The standard uncertainty is then multiplied by 2 to obtain the expanded uncertainty at 2 sigma (k=2).*

*This uncertainty calculation is consistent with the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (the 'GUM') and NIST Technical Note 1297.*

### NOTES AND SUPPLEMENTAL INFORMATION

*All temperatures given in this report are those defined by the International Temperature Scale of 1990 (ITS-90). For discussion of accuracies attainable with thermometers such as this device, see NIST Special Publication 250-23, ASTM E1, and ASTM E77.*

### TRACEABILITY INFORMATION

*This calibration is traceable to the International System of Units (the SI, or Système international d'unités) through NIST, via an unbroken chain of comparisons. Our primary temperature reference is a NIST calibrated SPRT (Standard Platinum Resistance Thermometer), used exclusively for the calibration of our secondary reference PRTs, which in turn are used to calibrate our clients' instruments. Measurement uncertainty, which increases at each comparison in the chain, has been calculated at each step and is fully documented.*

*ICL maintains three NIST calibrated Rosemount model 162CE 25.5 Ohm SPRTs, for redundancy and to permit sequential rotation to NIST for calibration. As of this date, traceability from -196 to 420 °C (-320 to 788 °F) is conveyed through S/N 5369, MTE-358, calibrated by NIST on May 28, 2015. NIST GMP-11 recommends a 36-month calibration interval for SPRTs. Secondary reference PRTs and other working standard thermometers are calibrated annually against this reference SPRT, per NIST GMP-11 recommendations, and are monitored continually using measurement assurance strategies including check standards, control charts, and documented monthly verifications at the triple point of water.*

*The comparators and working standards used in the performance of this calibration are indicated below, organized by test point.*

| Nominal temp | Comparator | MTE# | Manufacturer | Standard | MTE# | Manufacturer | Next Due |
|---|---|---|---|---|---|---|---|
| 81.00 °F | 7341 Water bath | 342 | Hart Scient. | 5614 PRT 528663 | 128 | Hart Scient. | 08/04/18 |
| 140.00 °F | 6022 Oil bath | 021 | Hart Scient. | 5628-12 PRT 0483 | 227 | Hart Scient. | 08/04/18 |

***TECHNICIAN:*** *Deborah M. Weber*

### ICL CALIBRATION LABORATORIES, INC.

*An ISO/IEC 17025 & ANSI/NCSL Z-540-1 accredited laboratory - American Association for Laboratory Accreditation Certificate #526.01*

*Approved by:* Deborah M. Weber *Reviewed by:* Lucy Accardi

*Deborah M. Weber, Quality Associate*
*J. Jeff Kelly, Senior Quality Associate*
*Michael C. Kelly, Technical Manager*
*Date report issued: 09-15-2017*

*This report document was prepared by Lori J. Parr*
*Recalibration date specified by client: September 15, 2018*

*The user should be cognizant that the indications of liquid-in-glass thermometers are dynamic with use and may change with rough handling, physical shock, thermal shock, fluid deterioration (from unclean capillary, impure filling, or other internal issues beyond the control of the user), and thermal cycling, among other factors. Calibration results and performance data obtained at time of calibration may not necessarily apply throughout an extended period of use. The magnitude and direction of these changes in indication, if any, can be determined by periodic recalibration. The user should be aware that any number of factors may cause this instrument to drift out of calibration before the specified calibration interval has expired.*



*This report applies only to the item calibrated. This calibration report shall not be used to claim product endorsement by the A2LA.*